

Claims Listing

Claims

We claim:

1-14 (Cancelled)

15 (Previously presented) Apparatus for monitoring refrigeration equipment or the like powered by electricity supplied by a suitable source, said refrigeration equipment or the like comprising an electrically powered compressor, an evaporator, a refrigeration chamber and an electrically powered defroster; said monitoring apparatus in operation periodically sensing the values of a selected group of operating parameters of the equipment, providing output data representative of the sensed values, and performing a series of equipment performance checks or tests on the output data thereby to identify existing or incipient problems with the equipment; characterized in that the monitoring apparatus is provided with sensors and sensed parameter data value inputs obtained from the sensors associated with the selected group of operating parameters, and that the said selected operating parameters include at least the following parameters:

- (a) the line voltage of the source of electricity;
- (b) the current drawn by the compressor;
- (c) the condenser pressure;
- (d) the refrigeration chamber temperature;
- (e) the evaporator pressure; and
- (f) the defroster current.

16-18 (Cancelled)

19 (Previously presented) Apparatus for monitoring refrigeration equipment or the like powered by electricity supplied by a suitable source, said refrigeration equipment or the like comprising an electrically powered compressor, an evaporator, a refrigeration chamber and an electrically powered defroster; said monitoring apparatus in operation periodically sensing the values of a selected group of operating parameters of the equipment, providing output data representative of the sensed values, performing a series of equipment performance checks or tests on the output data thereby to identify existing or incipient problems

with the equipment, and providing alerts or warnings for selected ones of the existing or incipient faults as (i) a high-alert signal if, for each such selected fault, the associated monitored parameter or parameters are of values that exceeds or falls below, as the case may be, a predetermined critical threshold as measured at a predetermined time or over a predetermined time interval thereby indicating that the fault condition is critical, and (ii) a low-warning signal if an existing or incipient fault condition is detected but the associated monitored parameter or parameters are of values that fail to cross the predetermined critical threshold; characterized in that the monitoring apparatus is provided with sensors and sensed parameter data value inputs obtained from the sensors associated with the selected group of operating parameters, and that the said selected operating parameters include at least the following parameters:

- (a) the line voltage of the source of electricity;
- (b) the current drawn by the compressor;
- (c) the condenser pressure;
- (d) the refrigeration chamber temperature;
- (e) the evaporator pressure; and
- (f) the defroster current

and that the selected performance checks include checks of the defroster current to reveal an existing or incipient fault condition that the defroster current is too high or too low, as compared with predetermined defroster current high and low threshold values.

20-23 (Cancelled)

24 (Previously presented) Apparatus for monitoring refrigeration equipment or the like powered by electricity supplied by a suitable source, said refrigeration equipment or the like comprising an electrically powered compressor, an evaporator, and a refrigeration chamber; the monitoring apparatus comprising in combination, a sensor for continuously or continually sensing the value of each said parameter; a discrete signal collection unit connected to each said sensor for providing over time a stream of digital parameter data representative of a series of sensed values of the parameter with which such sensor is associated; a general-purpose computer for coordinating the operation of the sensors and signal collection units and performing a series of performance checks on the equipment using the digital parameter data thereby to identify existing or incipient fault conditions in the

equipment; data storage means for storing selected data; a communications link from each said signal collection unit to the computer for transmitting the data streams to the computer under the control of the computer; and a display monitor connected to and receiving output from the computer for viewing selected data and selected performance check results; characterized in that the data storage means includes reference data providing a standard of comparison against which sensed data may be compared; the computer compares the data stream or selected data extracted or calculated therefrom with the reference data or selected portions of the reference data when performing the performance checks; and the computer output to the display monitor and displayed on the display monitor includes the results of selected performance checks; wherein the display monitor is or is incorporated into a pager and is remote from the computer and is connected thereto by a telecommunications link.

25 (Previously presented) Apparatus as defined in claim 24, wherein selected reference data is in the form of threshold values for selected parameters against which the computer compares current values of associated parameters in the course of performing selected ones of the performance checks.

26 (Currently amended) A method of monitoring refrigeration equipment having a compressor, a condenser, an evaporator and a refrigeration chamber comprising:

- (a) continuously sensing the values of selected operating parameters of the refrigeration equipment; and
- (b) performing equipment checks on the sensed values to identify existing or incipient problems with the refrigeration equipment;

wherein:

the sensed values of ~~at least one of the operating parameters are periodically sampled and recorded repeatedly in a computer database to produce a time series of the recent history of said operating parameter~~ at regular intervals and the sampled values are inserted into a database to maintain a time series of the recent history of each operating parameter, each time series comprising more than one pair of values, each pair of values comprising the sampled value of an operating parameter and a value representing the point in time at which the sample was sensed

and

~~at least one of the equipment checks is performed using the stored time series of sensed values of operating parameters~~ the refrigeration equipment is actively monitored for existing or incipient equipment problems by repeatedly retrieving the entire stored time series of the recent history of one or more operating parameters and tracking the trend of each said operating parameter by examining the interrelationship over time of values from each of the time series so retrieved from the database.

- 27 (Previously presented) The method of claim 26 wherein the selected operating parameters include the current drawn by the compressor and the equipment checks include at least one of:

locked compressor rotor high amperage;
long compressor on-cycle;
short compressor on-cycle;
long compressor off-cycle.

- 28 (Previously presented) The method of claim 26 wherein at least one of the equipment checks is performed by comparing the sensed value of an operating parameter with a suitable associated threshold value, said threshold value being calculated as a function of the time series of the recent history of the associated operating parameter during normal operation of the refrigeration equipment.

- 29 (Previously presented) The method of claim 28 wherein the selected operating parameters include:

the line voltage of the electricity source;
current drawn by the compressor;
compressor intake pressure;
compressor condenser pressure; and
the refrigeration chamber temperature

and

the problems with the refrigeration equipment identified by the equipment checks include at least some of:

power outage alert;

power restored warning;
high voltage warning;
low voltage warning;
no refrigerant pressure alert;
low cut-out pressure warning;
high cut-in pressure warning;
high condenser pressure warning;
high condenser pressure alert.

- 30 (Previously presented) The method of claim 29 wherein:
- (a) the refrigeration equipment further includes a defroster;
 - (b) the selected operating parameters further include the defroster current; and
 - (c) the problems with the refrigeration equipment identified by the equipment checks further include a high defroster current warning and a low defroster current warning.
- 31 (Currently amended) Apparatus to monitor refrigeration equipment having a compressor, a condenser, an evaporator and a refrigeration chamber comprising:
- (a) one or more sensors for continuously sensing the values of selected operating parameters of the refrigeration equipment; and
 - (b) a processor monitor for performing equipment checks on the sensed values to identify existing or incipient problems with the refrigeration equipment;

wherein:

~~the sensed values of at least one of the operating parameters are periodically sampled and recorded repeatedly in a computer database to produce a time series of the recent history of said operating parameter at regular intervals and the sampled values are inserted into a database to maintain a time series of the recent history of each operating parameter, each time series comprising more than one pair of values, each pair of values comprising the sampled value of an operating parameter and a value representing the point in time at which the sample was sensed~~

and

~~at least one of the equipment checks is performed using the stored time series of sensed values of operating parameters~~ the monitor actively monitors the refrigeration equipment for existing or incipient equipment problems by repeatedly retrieving the entire stored time series of the recent history of one or more operating parameters and tracking the trend of each said operating parameter by examining the interrelationship over time of values from each of the time series so retrieved from the database.

- 32 (Previously presented) The apparatus of claim 31 wherein the selected operating parameters include the current drawn by the compressor and the equipment checks include at least one of:

locked compressor rotor high amperage;
long compressor on-cycle;
short compressor on-cycle;
long compressor off-cycle.

- 33 (Previously presented) The apparatus of claim 31 wherein at least one of the equipment checks is performed by comparing the sensed value of an operating parameter with a suitable associated threshold value, said threshold value being calculated as a function of the time series of the recent history of the associated operating parameter during normal operation of the refrigeration equipment.

- 34 (Previously presented) The apparatus of claim 33 wherein the selected operating parameters include:

the line voltage of the electricity source;
current drawn by the compressor;
compressor intake pressure;
compressor condenser pressure; and
the refrigeration chamber temperature

and

the problems with the refrigeration equipment identified by the equipment checks include at least some of:

power outage alert;

power restored warning;
high voltage warning;
low voltage warning;
no refrigerant pressure alert;
low cut-out pressure warning;
high cut-in pressure warning;
high condenser pressure warning;
high condenser pressure alert.

35 (Previously presented) The apparatus of claim 34 wherein:

- (a) the refrigeration equipment further includes a defroster;
- (b) the selected operating parameters further include the defroster current; and
- (c) the problems with the refrigeration equipment identified by the equipment checks further include a high defroster current warning and a low defroster current warning.